A REVIEW OF THE STATUS OF TECHNOLOGY TRAINING FOR TEACHERS

by

Allen D. Glenn
and
Carol A. Carrier

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A Review of the Status of Technology Training for Teachers

Technology has become an important part of American education. Most elementary and secondary schools now have computers and more than 15 million students and 150,000 teachers use computers as a part of their school experience (Becker, 1986). Colleges and universities have also entered into the age of technology by modifying the curriculum and by providing increased access to computers for both faculty and students. Few educational institutions are untouched by the explosion of microtechnology. In fact, computer technology has become so much a part of the educational scene that critics are now coming forth to express their dismay at the unfulfillment of the earlier promises of technology.

Critics of computer utilization in the public school arena suggest that the movement has stalled because of a shortage of computers, the lack of high quality software, inconclusive research evidence for the effects of computers, and the teacher's own inadequate knowledge base (Dronka, 1985). In higher education some are suggesting that the computer professionals and computer companies raised unrealistic expectations among college administrators. Linda Fleit quotes one college president as saying, "Somebody promised me that computers and technology would make my institution more productive, easier to manage, and more sophisticated. None of these things has happened" (Fleit, 1986). As a result some administrators are calling a halt to the rapid expansion of computer technology on their campus.

On the other side of the argument proponents of computer technology suggest that changes will continue to be forthcoming. Gilbert Valdez (1986) suggests that the technology field has moved beyond the unrealistic claims of the early zealots to a more balanced understanding of what technology can and cannot do. The quick fix will not occur, but there is an intellectual regeneration occurring. Robert Taylor (Kendall & Budin, 1987) suggests that word processing, database building and use, graphical representations of all kinds, and telecommunications are all creating new environments for learning that will change teaching, learning, and schools.

Those individuals with a positive orientation toward computer use in the schools have been bolstered by the recent upswing in new products and sales. The recent two year slump in computer sales in which all major producers reduced payrolls and inventories appears to be over. A recent Time magazine noted, "No More Downtime (Bock, 1987) and suggested that Apple, Compaq, IBM, and Tandy are back on the road to success and making plans to make a significant push in the K-12 market. Similar headlines appear in the September 1987 issue of Classroom Computer Learning.

Critics and advocates, as well as researchers, manufacturers, and software developers, all agree that teacher training will play a critical role in the viability of computers in education (Office of Technology Assessment (OTA, 1987). The teacher is central to the growth of technology for two fundamental reasons. First, it is the teacher who will for the foreseeable future continue to be the major determinant of instructional activities in the classroom. Teachers

make choices about what is taught, when it is taught, and how it is taught. If computer technology is to have an impact on teaching and learning, teachers must understand the instructional issues surrounding the integration of the computer into instruction. Such an understanding cannot come without knowledge of the computer, experience in using it in learning situations, and opportunities to learn about more advanced applications of the technology in the curriculum.

Second, if the above assumptions are correct, training issues become central because the vast majority of today's teachers have had little or no training on how to use the computer. The most recent OTA report (1987) suggests that only about one-third of all United States teachers have had at least 10 hours of training. While no data are available, it is probably safe to assume that most of the training focused on introductory skills rather than instructional issues. This means that sustained efforts will be needed in inservice education. In addition to the needs to continue the training of the current teaching staff are the efforts needed to train teachers who will be joining the teaching ranks. The pressure to adequately train the beginning teacher may be exacerbated if the proposed teacher shortage occurs.

It is evident, therefore, that one of the major elements needed for continued growth in educational technology is teacher training. What is needed are better prepared beginning teachers and effective inservice education for teachers who are in the classroom. The answer seems to be straightforward. Determine as accurately as possible the training needs and allocate the resources needed to provide the training. The answer, of course, is not so simple nor is the solution

so easily attainable. The training of teachers to use technology at any level is just one of many issues facing both schools of education and public schools. Before one can understand the role of technology training, however, it is important to have an understanding of the broader context of teacher education in the 1980's.

Teacher Education Reform Efforts

Currently there is a nationwide effort to reform teacher education. The reform effort comes on the heels of several years of critical review of American public education and is the top priority for most schools of education. The heart of the national reform movement is best represented by two major reports, Tomorrow's Teachers: A Report of The Holmes Group (1986) and A Nation Prepared: Teachers for the 21st Century (1986). The first report was written by a group of deans from large, research-oriented colleges; the second by a group of political, business, and educational leaders. Both call for major changes in the manner in which teachers are prepared and in the schools in which they teach. They also call for higher standards for teachers and increased professionalism among those who enter and remain in the field. Some of the proposals for change have created considerable debate. For example, The Holmes Group (1986) recommends that the undergraduate education major be abolished and teacher education move to a postbaccalaureate degree program. Carnegie (1986) calls for a National Board for Professional Teaching Standards and national examinations. The response to these and other reports from various professional groups has been direct. For example, 90 schools of education have paid the $4,000.00 fee to join The Holmes Group and

become a part of its initiatives. Carnegie has funded a team of scholars to begin work on an assessment instrument to board certify highly skilled teachers.

Concomitant efforts to reform teacher education are also occurring at the state level. Teacher competency testing in at least the basic skills of reading, writing, and mathematics has been adopted in over 25 states. State departments of education have developed models of basic dispositions toward teaching that should guide the training of teachers. And, state legislatures such as Texas have passed specific laws regulating the number of credits permitted in teacher education programs.

Schools of education, as a result of these calls for reform, are spending considerable time and resources reviewing their teacher education programs. Deans of education feel the pressure to improve their licensure programs and to demonstrate that their particular school is responding to the opportunity available to them. But where does technology training fit into these reform efforts?

Technology Training in Teacher Education

Before discussing the place of technology training in teacher education, it is important to note two specific facts. First, preparing teachers to use technology is not a new issue with schools of education. In the 1970's schools of education scrambled to meet the demands for better technologically trained teachers. In fact, many were placed in a catch-up role with K-12 schools who had more equipment and better trained staff. Therefore, during the last decade schools of education purchased equipment, set-up laboratories, and added new

courses to the curriculum. Whatever the strategy employed, most efforts by schools of education were initially reactive in nature. Now a decade later to expect technology to remain at or near the top-of-the-list for an all-college agenda is probably expecting too much.

Second, some of the items on the reform agenda require significant changes in teacher education. For example, both The Holmes Group and the Carnegie Group call for a movement away from an undergraduate degree in education. This is a major curriculum change for almost all schools of education. While postbaccaluareate programs (students enter with a liberal arts degree) have existed for years, they are not the norm across the country. Most teachers are educated and prepared for licensure in undergraduate programs. Asking schools of education, for example, to eliminate their undergraduate teacher licensure program in elementary education in favor of a postbaccalaureate program calls for a careful rethinking of the curriculum. Or, asking schools of education to share in the education of beginning teachers more equally with public schools calls for the rethinking of roles for both institutions and reallocation of resources. As the September 2, 1987 headline in The Chronicle of Higher Education notes, "school-reform drive spotlights colleges' education of teachers."

At the same time the calls for curriculum reform are being considered, additional pressures face both schools of education and their parent colleges and universities. For example, changing demographics alter the number and types of students entering teacher education programs, and although enrollments for 1987 appear to have remained stable, colleges are competing for students. At the same

time, more people are questioning the costs associated with higher education and the overall quality of the education received. The result is a cacophony of voices seeking the attention of college administrators.

These examples illustrate the point that in this era of reform technology training is just one of many important issues confronting schools of education. This does not mean that deans and division heads are not cognizant of these needs. In fact, in August 1986 the Graduate School of Education at the University of California, Berkeley, with support from Apple Computer, Inc., sponsored a conference on technology and teacher education. Ninety participants from across the country, including deans of schools of education and directors of teacher education, attended. Among the themes discussed was the existence of barriers and problems inhibiting the incorporation of technology in teacher education. The conclusions of the discussion best summarize the issues surrounding technology education in today's schools of education.

Three important problems were identified. First, schools of education, like their counterparts in the public school, confront an environment of rapid technological change. Carl Berger, Dean of the University of Michigan, summarized the issue in the following way, "The problem is how to prepare teachers for hardware that is not yet invented, for software that is not yet designed, and for curricula not yet imagined. It's hard to have a vision of what technology will be" (Apple Report). Institutions who have spent a considerable amount of their scarce resources on equipment are now finding that it is dated

and that newer software demands more power, speed, and graphics. Unlike many technology purchases of the past (e.g., overhead and movie projectors), computers and related technology wear out faster and/or become outdated more quickly. Keeping somewhat up-to-date is much more costly than many administrators realized and in an era of tight budgets and retrenchment, it is easy to fall behind.

A second issue that has implications for the technology training is the movement by state agencies to regulate teacher licensure programs. California, for example, has moved to prescribe the type of technological experiences needed by teachers seeking permanent license to teach. Wendy Harris, Director of the Office of Educational Technology for the California State Department of Education, indicated that by July 1988 teachers must provide evidence that they have acquired certain computer competencies in order to obtain a clear (permanent) teaching license. The directive has come from the Commission on Teacher Credentialing based on the work of an advisory board of teacher educators, teachers and individuals from business and other agencies. Recent financial cuts in California's technology budget may have a significant impact on future training.

Similar technology efforts are taking place in Florida where David Brittain, Administrator of Educational Technology for the Florida DOE, said that plans are underway for certification requirements for teachers in the computing area and should be in place by July 1988. It will probably mean that teachers will be required to take a minimum set of technology courses. While this is a trend across the country, not all states are following this pattern. Paul Berg of the Alaska DOE

characterized Alaska's attitude toward legislating technology requirements as "maverick" in that such actions would "go against the grain" of the Alaskan value system. Alaska's independent philosophy may be unique; however, other states like Minnesota are discussing the pros and cons of such actions. According to Harold MacDermott, Technology Curriculum Specialist for the Minnesota DOE, discussion will continue and the DOE will provide documents that serve as guidelines for schools of education and their teacher education programs.

In addition to the technology requirement some states are legislating the total number of credits in the licensure program. For example, Texas has set a maximum of 18 credits for teacher education programs. Such restrictions put pressure on the teacher education faculty to develop a curriculum that meets the demands for initial licensure and still has "room" for areas such as technology training. Speaking of the situation in California, Harris noted that two major problems are encountered by teacher training programs. First, the teacher education curriculum is already crowded with required courses. Second, there is uncertainty about how to deliver the training, in a separate course or integrated into existing courses such as content methods courses. Answers to these questions are difficult and vary significantly across schools of education.

The final issue raised during the Apple conference was best summarized by Dean Alphonse Buccino of the University of Georgia. He noted, "A substantial portion of a teacher preparation program of a university is carried on outside the jurisdiction of the school or college of education. Often schools of education must cope with

unintegrated programs in general education, excessively narrow subject area majors, and poor teaching role models in undergraduate education" (Linn, 1986). General computer literacy is a responsibility shared with the larger college or university environment. For example, in California some of the general computer literacy requirements must be acquired before students enter the fifth year training programs. The schools of education do not have control over these courses. While schools of education are devising methods for enhancing the knowledge and skills of their students, other efforts are occurring outside the school. Coordinating these learning experiences or building upon them often is a difficult task.

These problems are real and must be considered as part of the total agenda for any school of education. It does not mean, however, that answers are not possible or that insights are not available. Deans and directors of teacher education can draw upon a variety of national and state organizations for insight into what should be done to train teachers more effectively.

National and State Organizations

The most positive statement about the role of technology in the new curriculum of teacher education is found David C. Smith's chapter, "Redesigning the Curriculum in Teacher Education", in Strengthening Teacher Education: The Challenges to College and University Leaders (1986). Smith includes technology as a part of the foundations curriculum. He suggests that the beginning teacher needs to have experience in:

computer applications in education (with some adaptation made to grade level and field); computerskills and applications useful to teachers (such as record keeping and word processing)
(Smith, p. 91)

Professional education organizations have also developed general policy statements about the use of technology in the school and in the preparation of teachers. While there are many organizations representing teacher educators, only a selected sample was chosen for this report. Ten were selected that were representative of two general categories (See Table 1).

Table 1
National Organizations

Group 1
American Association of Colleges for Teacher Education
Association for Supervision and Curriculum Development
National Council for Accreditation of Teacher Education
Group 2
American Federation of Teachers
International Council on Computer Education
National Association of Secondary School Principals
National Council for the Social Studies
National Council for the Teachers of English
National Council for the Teachers of Mathematics
National Education Association

The first group is composed of general teacher education organizations or accrediting agencies. The second represents content specific organizations. The director or key representative was sent a letter of inquiry seeking specific information (See Appendix for a sample of the letter). Each agency responded.

Generally speaking, most national organizations have not developed detailed position statements on technology nor have they conducted research in the area. What specific statements that do exist are usually contained in broader statements about overall educational policy. Specific recommendations about the future direction of technology in teacher education were not clearly evident in any of the literature received from the organizations.

Group 1 responses: The American Association for Colleges of Teacher Education (AACTE) is the largest organization for professors whose primary interest is teacher education and publishes one of the major journals in teacher education entitled The Journal of Teacher Education. The association has a membership of over 700. In a position statement developed in 1986 entitled "Technology and Teacher Education" AACTE outlined ten critical considerations for schools, colleges, and departments of education. Critical consideration four speaks directly to technology training in teacher education programs.

> Information technologies area a means rather than an end in the educational process.
>
> Courses on media or computer programming isolated from specific instructional applications are of limited value; rather, instruction on the use of technology should be integrated into appropriate courses. Instruction about how to use technology is needed only to the extent that such provides clear, functional understanding about how to integrate technology into instruction. SCDE's should emphasize instruction on how to use new technologies to enhance the effectiveness of the teaching process (AACTE, p. 4).

Other issues discussed suggest that all professionals need training in using technology, deans are critical to the successful implementation of information technologies, faculties in colleges of

education should play a major role in the production of needed knowledge, and colleges of education administrators and faculty have a responsibility to keep themselves informed about technological changes and new products. The document also includes a set of recommendations about "moving forward" in this area. Like many policy statements, the document is general nature and leaves the specifics to individual institutions.

The National Council for Accreditation of Teacher Education (NCATE) is another national organization with two broad goals: (1) to require a level of quality in professional education that fosters competent practice of graduates, and (2) to encourage institutions to meet rigorous academic standards of excellence in professional education (NCATE, October 1986, p. 1). Accreditation by NCATE is voluntary on the part of schools of education. Currently there are about 500 institutions that have NCATE approved teacher licensure programs. Within the professional studies standard technology training is noted in two areas (NCATE, October 1986, p. 29). The first is as a part of the traditional foundations area in which students should understand the "impact of technology and societal changes on schools" and in the professional studies component in which students should be prepared to use "instructional technology." Technology training also appears as a part of the programs in teacher education and the area of "symbolics of information" (NCATE, November 1986, p. 27). The following areas are noted as important criteria. These are:

Professional Studies Component:

> The study of teaching and learning theory includes a basic understanding of all media, materials, and

technology and of the processes of communications as related to learning and the instructional task.

The systematic use of media, materials, and technology should be a part of the teacher trainee's experiences when approaching the study of teaching and learning theory.

Media, materials, and technology should particularly serve the clinical needs of the professional studies component of modern teacher education programs.

Practicum:

Direct, substantial participation in teaching should include realistic opportunities to use media, materials, and technology, under personnel qualified to help direct the application of such material.

These standards require that general media instruction be a component of the professional studies of the beginning teacher. The guidelines are so general in nature, however, that it is difficult to determine the exact role of computers and related technology in these experiences. For example, there is no definition of "technology" within the document; therefore, although one would assume that computer education would be an important part of an education program, it is not guaranteed with these standards.

The Association for Supervision and Curriculum Development (ASCD) publishes Educational Leadership, a well-known journal. ASCD through its journal and office in Washington, D.C. provides considerable general information on the role of technology in education. For example, the March 1986 issue of Educational Leadership theme was on "Empowering Students and Teachers Through Technology." In addition, the organizations research division provides bibliographies of important journal articles and other references. Specific statements

about what needs to be done to prepare teachers to use technology have not been developed by the organization as a whole.

Group 2 responses: The International Council of Computer Education (ICCE), one of the leading proponents of using technology in the classroom, publishes a major journal, The Computing Teacher, and a second focusing on teacher education, the SIG Bulletin. It also sponsors a national conference on technology and the schools, National Educational Computing Conference. The ICCE continues to promote dialogue among educators focused upon the competencies for classroom teachers and individuals seeking to become computer coordinators. The goal of ICCE is "to formulate recommendations and guidelines for state committees to use in developing their own teacher certification requirements and for Schools of Education to use in developing their computer education curriculum" (Jonagegan, 1987). The ICCE recommendations call for all teachers to understand the computer as a system, to be able to use computer applications in education, and to use the computer as a tool for personal use. ICCE's orientation for teachers who teach computer courses focuses on a sound background in computer science and supports the training recommended by the Association for Computing Machinery (ACM) which has a core of study focused on hardware and programming languages. For computer coordinators ICCE recommends a broader base of training that includes supervision, curriculum development, administrative skills, and knowledge of future directions. ICCE, according to their position statements, seeks to provide the stimulus for grass-root discussions about technology competence among teachers.

A statement from the National Association of Secondary School Principals' Association (NASSP) office best summarizes the responses from the other respondents in Group 2. Mr. Scott Thomson writes, "While the NASSP is centrally interested in the use of technology in education, we do not focus on teacher education because of our limited resources" (Thomson, 1987). National organizations such as NASSP do not focus their attention on teacher education issues; they focus on broad issues related to the particular discipline or to curriculum content issues. At best these organizations may provide general policy statements such as those adopted by the American Federation of Teachers in which resolutions are passed that support the opportunity for all teachers to have access to computers within the school and that training in computer use and function be made available on a voluntary basis to all interested faculty members (Rosenberg, 1987).

As noted earlier, schools of education can also receive direction in their efforts to provide technology training from directives and documents from the various DOEs. In some cases, legislation is being passed to prescribe competencies (California and Florida) while in other cases guidelines are provided (Minnesota and Alaska). Schools of education, however, are not without experience in developing their technology training programs. For over a decade they have been involved in both preservice and inservice teacher training. Both areas can be examined for additional insights into what educators should be doing in the future to better prepare teachers to utilize technology as a part of the instructional process.

Preservice Technology Education

In 1986 the National Center for Education Statistics estimated that 144,000 new teachers were licensed to begin their careers (Feistritzer, 1986). These beginning teachers were prepared in over 1,500 private and public institutions in teacher education programs ranging in size from those preparing a small number of teachers to those institutions that graduate several hundred each year. In almost all of these teacher licensure programs prospective teachers had some access to training in computers.

Preservice Courses: A Brief History

With the introduction of the microcomputer in the late 1970's, teacher licensure programs responded to the pressure to better prepare their candidates for using the computer as both a personal and instructional tool. As the number of computers increased in schools, colleges, and universities, teacher licensure programs responded in two ways. First, a set of guidelines or computer literacy statements spelling out the school's philosophy about computers and education were created. Second, the teacher licensure curriculum was modified to include either a specific course in technology and/or the modification of selected methods courses to include technology.

Although the literacy statements varied considerably from institution to institution, the University of Minnesota College of Education's literacy statement developed in 1983 is typical of many institutional plans and has been documented in the literature (Carrier & Lambrecht, 1984). Drawing upon the work of Daniel Watt (1980), an all-College Technology Task Force defined computer literacy as:

> ...the skills, knowledge, values, and relationships that allow the teacher to comfortably use the computer as an instructional tool to prepare students to be productive citizens in a computer oriented society.

To meet the College goal of preparing a computer literate teacher education graduate, seven specific competencies and one optional competency were developed (see Table 2).

Table 2

Basic Computer Literacy Competencies
College of Education
University of Minnesota

The computer literate teacher should have:

1. knowledge of basic computer components and operation.
2. knowledge of materials and projects related to computer education.
3. knowledge of educational and personal uses of the computer.
4. knowledge of individual differences as they relate to computer-assisted learning.
5. an ability to evaluate instructional software.
6. an ability to develop/manage an environment in which computers are available for teaching/learning.
7. knowledge of educational and societal implications of the "information age."
8. (Optional) an ability to use authoring languages and to program.

Source: Carrier, C.A., and Lambrecht, J.L. (1984). Preparing teachers for using computers in instruction. Educational Technology, 16-20.

Optional competency eight, authoring languages and programming, was symbolic of the major controversy of the early years of technology

training for teachers. Considerable energy was expended throughout the profession discussing the pro's and con's of teaching teachers to program.

Proponents suggested that by learning to program much of the mystery surrounding the operation of computer programs would be removed and the teacher would have greater flexibility in using the computer (Bramble, Mason, & Berg, 1985, p. 225). Proponents also suggested that teachers needed programming skills in order to modify software and develop their own materials (Singletary, 1987), to feel better about themselves as a part of the computer literate society (Culp, 1986), or to become better problem solvers (Luehrmann, 1985).

Other educators (Moursund, 1986; Friedman, 1982; Nietzke, 1985) suggested that computer literacy skills should focus on using the computer as an instructional and personal tool, as a medium for data storage and analysis, and as part of the instructional strategies utilized by the teacher.

Although a variety of literacy statements were drafted in the late 1970's and early 1980's, only one of the 15 largest schools of education based on the number of education graduates in 1982 reported having a computer literacy requirement for graduation, Illinois State University (Ross & Rochford, 1987). While no specific data are available, it would be safe to assume that the other 14 and many of the other institutions across the nation had done some modification of the curriculum to meet the increased demands for more technologically trained teachers.

Once literacy statements were developed decisions were made about what approach should be followed in providing the training needed to achieve the designated goals. One philosophical approach favored a required introductory computer programming course for all students. Another assumed that no one course should be developed to meet all the goals, that faculty from across the college should be involved in the effort, and that programming need not be a requirement. Elementary education students, for example, were to learn about specific applications of the computer in critical areas of the curriculum such as mathematics through their methods courses. While they might take an introductory course, the instructional needs were to be taught in content courses.

During the late 1970's and early 1980's schools of education discussed strategies which would be most appropriate for their institution. Decisions often were based on the point-of-view of the dominant computer expert on the faculty. For example, if an advocate of "programming-for-all" was the most dominant voice, the philosophy would be followed. If a spokesperson for a nonprogramming approach held sway, such a program emerged. No data are available from those early days of preservice education that would suggest the effects of either of their points of view on the actual type of training provided or its quality.

Computer Literacy in 1987

In 1987 several important changes have occurred that directly affect teacher technology training programs. First, the general knowledge level of entering students has changed significantly. High

school students now have at least minimal experience with the computer. Approximately 60 percent of entering freshman have experience using the computer (Turner, 1987). A traditional computer literacy course focusing on programming has been replaced by more tool-oriented courses in which students learn word processing, data management, and data analysis skills. Students are no longer satisfied to learn programming as their basic introduction to the computer. This change in the experience level of the student entering the teacher education program has meant that not all learning has to begin at the very basic level. Teacher education programs can expect, like the California regulations, that some general computer skills should be acquired prior to entering the program.

Second, many college faculty have increased their knowledge and use of computers in their own academic area. Turner (1987) suggests that the general literacy level among faculty has increased and this knowledge has changed the manner in which some professors teach and conduct research. These activities, in an indirect way, influence the students' knowledge of how the computer can be used as an instructional tool. Word processing is probably the most common tool used by faculty across the college or university.

Third, commercially available software has become easier to use, more powerful, and more useful. In the 1970's a potential teacher needed considerable knowledge about the technical aspects of the computer in order to load and run a program. While not as user-friendly as commercial developers would suggest, today's programs are

much easier and several times more powerful than those programs of five years ago.

Fourth, state departments of education and professional organizations are providing guidelines for technology. The Minnesota Task Force on Teacher Education for Minnesota's Future report entitled **Minnesota's Vision for Teacher Education: Stronger Standards, New Partnerships** (1986, p. 1) "focused on what beginning teachers should know and how they should act to promote the greatest learning and understanding in their efforts with students." The final document is a model of teacher education that is to be used as a guide for schools of education throughout the state and for state agencies in evaluating teacher licensure programs. Although not specific in nature, the document makes note of the teacher's need to "use state-of-the-art communication technology and information systems (Task Force, p. 26), "technological language and communication (p. 28), and knowledge about effective learning and teaching as they relate to technology (p. 29). Documents like these are providing data for further discussions about the curriculum of technological training for teachers.

Similar efforts are occurring in other states and regions. In an effort begun in 1984 the Northwest Council for Computer Education (NCCE) has developed a set of guideline competencies to aid in the development of teacher education programs (Moore, 1985). The project identified two areas, general teacher education requirements and specific computer education requirements. The goal was to provide general guidelines for those schools of education in the Washington and

Oregon region interested in preparing teachers in these two areas. The general education competencies are listed in Table 3.

Table 3

General Teacher Competencies in Technology

The teacher should:

1. have an appreciation for using the computer as a tool for solving problems.
2. have the experience of using computers in the learning of subject matter.
3. have knowledge of computer vocabulary.
4. be able to use the computer as a tool (using applications such as word processing, spreadsheet analysis or data base management).
5. be familiar with computer hardware, including the everyday operation and use of a variety of machines.

Moore, N. (1984, October). Preparing computer-using educators. The Computer Teacher, 48-52.

Other states are providing specific rules and regulations about the preparation of teachers. As discussed previously, California State Assembly Bill No. 1681 specifies that beginning July 1, 1988, candidates for a clear (permanent) teaching credential in the state must satisfactorily complete computer education coursework that includes "general and specialized skills in the use of computers in educational settings" (Blurton, 1986-87). Included in the law is the charge to develop specific regulations regarding these skills and to disseminate voluntary standards for the training and performance of

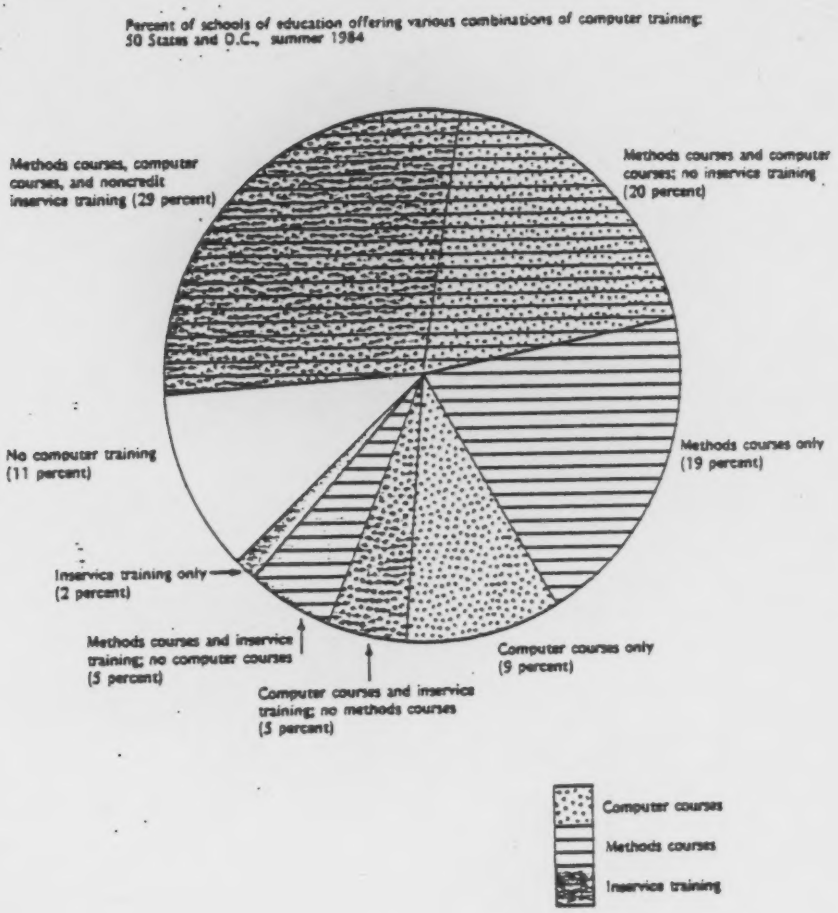
teachers and resource personnel in computer education. Other states are considering similar legislation.

In 1987 almost all the schools of education in the United States gave prospective teachers some access to computers. According to a Department of Education survey of teacher education institutions in 1984 (OERI Bulletin, 1986), two types of courses typify most offerings. The first devotes over 80% or more of the class period to computers as objects of learning or to their use as learning or teaching tools. The second devotes only a small portion of class time to computers and focuses primarily on techniques of using computers for teaching subject matter (OERI Bulletin, 1986). The breakdown of these courses for 1984 is shown in Figure 1 (page 25).

At the preservice level the most common computer course available to students is the introductory course. According to the Department of Education data (see Figure 1) the vast majority of schools of education offered some variation of this course. Often the course may have been listed at the graduate level to accommodate both undergraduates and graduate students. A smaller portion of the computer experience is in the methods courses. If such training were occurring in 1984, it would be safe to assume that the level has not declined during the past three years and has probably increased slightly.

It is important to realize, however, that the effort to infuse technology into the traditional methods course is still a difficult task. A survey by Moore (1984) and presentations by Professors Bitter (Arizona State), Hannah (California State, Sacramento), and Scherer

Figure 1


Percent of schools of education offering various combinations of computer training: 50 States and D.C., summer 1984
Methods courses, computer courses, and noncredit inservice training (29 percent)
Methods courses and computer courses; no inservice training (20 percent)
No computer training (11 percent)
Methods courses only (19 percent)
Inservice training only (2 percent)
Methods courses and inservice training; no computer courses (5 percent)
Computer courses only (9 percent)
Computer courses and inservice training; no methods courses (5 percent)
Computer courses
Methods courses
Inservice training

Source: U.S. Department of Education, 1986

(Bowling Green) at the 1987 National Educational Computing Conference suggest that many issues such as faculty training, access to appropriate software and equipment, and adding another topic to a crowded course syllabus remain as real problems. It is often easier

to provide a separate course on using the computer, than to convince, train, and support methods instructors.

This does not mean that movement has not occurred. Access to computers for faculty has increased (Turner, 1987). As a result, faculty skills have increased. Discount purchasing plans, colleges purchasing computers for faculty, and alliances with business to provide equipment, software, and training have all had an impact on faculty expertise. Some colleges have instituted plans to train faculty. Such preparation does not need to be exorbitantly expensive or time consuming. Professor Betty Collins, current president of ICCE and an associate professor of education at the University of Victoria, described an interesting and relatively inexpensive approach to helping faculty in methods courses begin to use computers in their own teaching. Collins was released from one of her courses for the year so that she could team up with methods instructors in all subject matter areas to introduce computer-related activities within existing courses. In one year she helped out with more than 60 such class activities. She indicated that a key to the success of this program was working with the instructor to identify a key problem or topic that he or she believed was extremely important and then using the computer as an aid to teaching that topic. Many of the methods instructors had never used the computer in their courses and as a result of their work with Collins, began to explore other uses. As confidence and expertise increase so to does the probability of use.

In 1984 about 20,000 microcomputers were available for education students (OERI, p. 2). The typical configuration is an

"instructional/lab facility" in which courses are taught and when not in use serve as open laboratories. As colleges and universities have moved to create general computer laboratories across the institution, education students have gained more access to computers. To support these efforts colleges and universities have begun to charge a fee. A 1987 survey by Electronic Learning of 41 institutions found a third charging fees (Shalvoy, 1987). A sample of the fees are shown in Table 4. Not everyone surveyed, however, believed a special fee should be assessed. Cost, according to these individuals, should be a part of general tuition fees.

Table 4

Student Computer Lab Charges

SCHOOL / ENROLLMENT	FEE STRUCTURE	EXPECTED REVENUE FROM FEES 1986-87	FEE INCREASE OVER LAST YEAR	CHANGE IN FEE FOR 1987-88
University of Michigan Ann Arbor, MI 34,000	$100 per student	$3,400,000	Yes	Same
Montana State University Bozeman, MT 10,745	$1 per credit per quarter, maximum: $12 per quarter	$ 335,000	No	Same
New Mexico State University Las Cruces, NM 12,000	juniors/seniors: $35 per semester freshmen/sophomores: no fee	$ 175,000	Yes	Same
Pan American University Edinburg, TX 9,444	micro $15 per semester mainframe $9 semester	$ 4,000- $ 6,000	Yes	—
Illinois State University Normal, IL 20,610	$1 per hour or $30 per semester	—	Yes	Same
Oregon State University Corvallis, OR 17,682	$1.50 per hour minimum: 1 hour	—	—	Same

Source: *Electronic Learning*, Vol. 6, No. 4, Jan, 1987

In an Electronic Learning survey conducted by John Ross and Terry Rochford (1986), it was found that among the 15 schools that graduate the largest numbers of teachers ten reported having a computer literacy course requirement for graduation (See Table 5). Three reported that they incorporate units of computer education into general methods classes. Two schools indicated that students had to demonstrate specific computer literacy competencies through coursework, life experience, or work experience. Of the fifteen institutions only one school offered an undergraduate degree in computer education. And, the degree was for secondary school students only.

Combining the Department of Education data and information from the Electronic Learning survey and emerging state requirements, one may conclude that tomorrow's teachers are receiving at a minimum an introduction to the instructional uses of the computer. When combined with some of the other computer experiences students have prior to entering teacher education programs, these beginning professionals may be minimally prepared to begin using the computer. Are they?

Do schools of education graduates feel they are prepared to use the computer? Unfortunately, few data are available at the national level to provide insights into this question. The professional literature contains no surveys of students' attitudes or assessments of computer skills. The studies that are reported tend to focus on questions about the existence of computer training programs, the types of courses offered, and the number of computers available for instruction. Such surveys reflect the current conditions of technology

Table 5
Computer Literacy Requirements:
15 Largest Schools of Education in the U.S.A.*

University	Required for Graduation	Required for Certification
California State Los Angeles, CA	No	No
Pan American College Edinburg, Tx	Yes	Yes
Brigham Young Provo, UT	Yes	Yes
Ohio State Columbus, OH	Yes	N/A
Oregon State Corvallis, OR	Yes	No
U. of North Dakota Grand Fords, ND	Yes	N/A
Illinois State Normal, IL	Yes	N/A
U. of Wisconsin Madison, WI	No	Yes
U. of Northern Colorado Greeley, CO	See note 1	N/A
Western Kentucky State Bowling Green, KY	See note 2	N/A
North Texas State U. Denton, TX	Yes	N/A
Central Michigan Mount Pleasant, MI	No	N/A
Glassboro State Glassboro, NJ	Yes	Yes
Southwest Texas State San Marcos, TX	Yes	Yes
Georgia State Atlanta, GA	Yes	N/A

* Adapted from data presented in Ross, J. and Rochford, T. (1986), "New Teachers Better Prepared for Computers" Electronic Learning, vol. 6, no. 4, pp. 23 - 24.

[1]Elementary and Secondary Ed majors must demonstrate competency

[2]Computer competency must be demonstrated by working in the computer lab under the qualified supervisor

training in both higher education and the K-12 sector. Efforts have been made to focus on "What is?" rather than "Is it effective?" This is not to demean this type of work, but simply to note that this is a common evolutionary pattern in research in a new and ever-changing field. The data that do exist are usually individualistic and school specific in nature. Professors evaluate their own courses to receive feedback, but such results are seldom shared with a broader audience. Also, schools of education collect data for internal use for internal program evaluation and for use with outside accrediting agencies. The data are usually gathered via a questionnaire sent to recent graduates and over a period of years. These data are seldom published in the literature. Given these are common practices across institutions, data gathered from recent graduates from the College of Education at the University of Minnesota may be illustrative of the impact of schools of educations' efforts to provide better technology training for preservice teachers and of the efforts needed in this area in the future.

As a result of a survey of graduates from 1980-81 the College of Education at the University of Minnesota made a concerted effort in 1982 to improve the preparation of its teacher licensure candidates in the area of computer education. College-wide reports from graduates teaching in 1980-1981 indicated that they had received almost no preparation in using computers in the classroom (See Table 6). This was not a surprise because there had been little attempt to infuse technology into the curriculum or to provide a course on technology available to all students. As a result, a more effective instructional

computer laboratory was created, a special introductory course was designed, and efforts were begun to introduce technology into the methods courses at both the elementary and secondary level (Glenn, 1984). In a follow-up study of graduates from 1985, the mean score, 2.625, indicated that students were being prepared but the preparation was not sufficient (See Table 6). The trend line was encouraging; however, it is evident that more efforts need to be made to insure that students acquire needed skills. It should be noted that the response means reflect a graduate's perception after one year in the classroom.

Table 6
Results from Annual Second Year Follow-up
of College of Education Graduates*

How would you rate your preparation to do these things?
1 = no preparation
2 = poor preparation
3 = fair preparation
4 = good preparation
5 = very good preparation

Item	Year/Mean Score				
Using computers in the classroom.	1980-1981	1981-82	1982-83	1983-84	1984-85
	1.684	1.929	2.140	2.545	2.625

*From Strom, S.M. (1987). Summary of findings from the 1986 survey of graduates, College of Education, University of Minnesota.

The Minnesota example illustrates several issues. Preparing preservice teachers to work effectively with technology is a complex task. Introductory courses that are not required must be fit into already filled course sequences and not all students find time or funds to take the course. Technology training in methods courses is limited

in nature because it is not central to the subject matter of the course. Many schools of education are also faced with licensure programs that have hundreds of graduates. Providing in-depth technology training for all students becomes a complex challenge of balancing staff and resources. Finally, it may not be possible for preservice education to provide the level of technology instruction needed for an individual to effectively use technology during instruction. Preservice technology training may be able to provide introductory skills only. Inservice and continuing education, subjects of the next section, may be areas in which advanced training must occur. It is clear, however, that in the coming years schools of education will need to turn their attention to the impact of the technological training efforts on preservice teachers' knowledge, skills, and attitudes. Considerable resources have been allocated to meet the demands of computer literacy. "Have these resources been well spent?" will become a more critical question during the next several years.

Areas of Needed Research

Preservice teacher technology training has not been an area of focus for educational researchers. Although individual course evaluations are common as are evaluations from an all-college perspective, few studies exist in the literature that focus on technology training and preservice education students.

Since during the next several years significant numbers of teachers will be leaving the schools through retirement and there is a potential

teacher shortage, it is critical that educators examine the following issues related to technology training at the preservice level.

* What are preservice teachers perceptions of the training they have received as a part of their teacher education program?
* What technology skills must be taught prior to teaching curriculum applications?
* What techniques can be used to assess preservice teacher technology competencies?
* Which approach, specific course or integrated methods, is more successful in teaching basic skills, and instructional strategies?
* How much training is needed to prepare the preservice teacher so that (s)he feels confident in using technology in the classroom?
* Which skills are essential for preservice instruction and which ones should be delayed until the initial year of teaching?
* What type of technology experiences should be included in practicum and student teaching? How much training should occur on-site in the school?
* What models of technology training are most effective for different types of teacher education programs? For example, institutions that annually graduate 500 beginning teachers have different

problems than small programs that graduate fewer than one hundred students.

* How much introductory technology training can be delivered via technology and in individualized manner? Would such an approach be as successful as the traditional single course format?

Recommendations

In 1986 144,000 individuals received their teaching degree. Assuming a growth in computer activities in schools of education since the Department of Education's survey in 1984, most of these graduates had some minimal training on how to use the computer in the classroom. Based on the available data about preservice teacher technology training and the unanswered research questions noted above, it is evident that several important recommendations may be made about needs in preservice education. The following recommendations are based on the analysis of the current state of preservice teacher technology training and can serve as indicators for teaching, research, and policy activities.

Recommendation 1: Schools of education, K-12 schools, and departments of education need to establish guidelines to insure that competence with technology is part of the exit requirements for all beginning teachers.

During the next several years important revisions will take place in teacher education programs. It is critical that the technology training of beginning teachers be integrated into the new curriculum of teacher education. Schools of education, K-12 schools, and departments of education within each state need to work cooperatively in establishing guidelines for technology training. Preparing teachers to

use technology is a complex and expensive task. Each partner cannot achieve the goal of a computer literate beginning teacher alone. Resources and expertise must be used effectively.

Recommendation 2: Schools of education need to establish technology training programs for faculty from across the teacher education program.

Faculty within specific licensure areas must be trained to share in the responsibility for preparing preservice teachers to use technology effectively in the classroom. A cadre of technology literate "methods" faculty must be available to support and expand the efforts of technology faculty. The methods instructors must be able to serve as role models for beginning teachers. While the development of competent faculty is important in all institutions, it is especially critical for larger institutions where a major portion of a student's educational program is taught directly by content specialists.

Recommendation 3: Schools of education need to work cooperatively with the college or university at large in establishing computer literacy requirements and courses.

During the next several years students entering teacher education programs will have more experience using computers than those students in the past. This will be especially true for the schools of education that have fifth year teacher education programs. If students are more computer literate, schools of education need to work with their colleagues in the liberal arts to insure that education students enter programs with appropriate skills.

Recommendation 4: Schools of education need to conduct research studies to answer the questions posed in the preceding section.

The research base in teacher technology education is a virtual desert. Schools of education have been in a reactive mode for the past

decade and most researchers have focused their interests on the impact of computers on students learning and attitudes. If educators are to begin to understand the role of training in helping teachers use computers more effectively, research activities must be initiated. Since resources at the collegiate level are always quite limited, both the federal and state agencies related to technology need to include such research activities in their funding agenda.

Recommendation 5: Schools of education need to explore establishing cooperative relations with business and industry.

Historically schools of education have not established cooperative relationships with business and industry. Because of the costs involved in maintaining up-to-date equipment and emerging software, schools of education cannot maintain a state-of-the-art technology program. A more detailed discussion of this area is presented on later in this report.

Conclusion

During the next decade many teachers will be leaving the profession and new teachers will be beginning their careers. In some states severe teacher shortages are projected while in others the demand may be less. Whatever the case, it appears many new teachers will be entering the profession. It is also evident that another computer expansion is occurring and that new technologies will continue to change the character of American education. Beginning teachers must be minimally prepared to use technology and to understand its instructional potential.

Inservice Technology Training

Schools of education prepare an individual to begin a career as a classroom teacher. On receiving a license the teacher may continue professional studies by attending a graduate institution, enrolling in special seminars, and participating in a variety of inservice programs offered by the school district. In fact, the most consistent professional education experience for a teacher is the inservice program sponsored by the district. At least once during each year all teachers attend some type of inservice workshop on a topic of their choosing or of the district's sponsorship.

During the last decade considerable resources have been allocated to inservice technology training. Districts have utilized a variety of approaches in attempting to provide the training needed to have teachers use computers effectively in the classroom. This section focuses on these efforts from two broad perspectives, general principles about effective staff development and findings from research studies on inservice technology training. Before discussing these two topics however, several general points need to be considered.

First, technology training involves unique requirements that distinguish it from inservice activities in more traditional subject matter areas. The need for a well-equipped facility is perhaps the most obvious example. While it is possible to run an inservice session on a new reading or mathematics technique in a traditional classroom, teaching teachers to use a word processing or gradebook program is only effective if they can work individually or in pairs at a computer. But despite special requirements, there is much to be gleaned from the

literature on effective staff development training that can be applied to technology inservice training.

Second, it must be pointed out at the outset that there has been little empirical research on inservice technology training for teachers. Much of the literature takes the form of descriptions of courses or programs, prescriptions for how technology training should take place, or reports of survey statistics. Only a few empirical investigations of specific methods or programs are available.

In fact, despite the widespread acceptance of the need for teachers to receive computer training, research on methods or models of such training is sparse. The focus of research typically has been the student rather than the teacher as exemplified in studies of the effects of computers on student behaviors and attitudes (Kulik, 1983; Kulik, Bangert & Williams, 1983) and national surveys estimating student time spent working with computers or reporting numbers of computers per student in schools (Becker, 1986).

A deterrent to conducting research on inservice technology training has been the difficulty of assessing transfer of training content to the classroom. Teachers can apply what they have learned in an inservice session only if they have convenient access to the technology once the inservice has ended, both for gaining confidence through practice and for application in the classroom. A teacher who has learned to use a social studies database program in a workshop must have access to computers to try out the program with students if it is to remain fresh in her mind. The difficulties of assessing transfer

plague all research on staff development but no more so than in technology training.

Effective Staff Development

The position taken here is that there is no single, superior method of staff development that will work equally well with all teachers for all topics. Certain characteristics of staff development do have generalizability to many topics and many types of teachers, however.

Sparks (1983) reviewed a large number of studies that reported data on the effects of various staff development approaches and variables. Her analysis led to a description of five components that seemed to characterize effective staff development approaches, with effectiveness usually defined in terms of changes in teacher behaviors:

* Diagnosing and prescribing
  Begin with teacher's current level of expertise

* Giving information and demonstrating
  Sensitive presenters
  Live models, videotapes, simulations

* Discussing application
  Sharing ideas
  Teacher-to-teacher interactions

* Practicing and giving feedback
  Microteaching
  Peer observation

* Coaching
  Receiving feedback
  Nonthreatening assistance

In addition to these components there are other factors that will influence a teacher's ability to learn new skills within the context of staff development or training activities. Teachers, as persons and professionals, differ from one another in a variety of ways.

A most powerful set of characteristics that affect how teachers approach the use of technology are their concerns or anxieties when introduced to computer technology. Williams and Williams (1984) in their book **Microcomputers in Elementary Education: Perspectives on Implementation** suggest dimensions of teacher computer attitudes that lead to concerns and anxieties. Briefly summarized there are several key dimensions.

1. Fear of Uncertainty: What exactly is a computer? How does it function? Teachers are in charge in the classroom. If they don't know about something, it can lessen authority.
2. Fear of Change: Change always means altering one's role. If things are going well, why change?
3. Fear of Technology that Changes Teacher/Student Relationships: Computers often motivate students, reinforce basic skills, keep records, focus attention, simulate environments, calculate, and give immediate feedback. They can do many of the things teachers do. Teachers see that students are often much more enthusiastic about working with computers than with the teacher. Computers also can store considerable data. They may "know" more than the teacher about certain things. Computers alter roles and relationships. Some teachers are uncomfortable with these changes.
4. Fear of Accountability: Computers make it easier to meter productivity. Student scores can be monitored and teacher success can be "checked" against these scores. Accountability tied to centrally kept records creates concerns.

This section has examined inservice practices that lead to the growth of knowledge and skills in teachers. Teacher characteristics that affect how receptive teachers will be to learning new things, how much structure or flexibility they will need, or how anxious they will be about implementing new techniques have also been considered. From this literature a strong case can be built for following certain general principles when designing technology inservice programs. A closer look at three studies that produced data about different inservice technology training programs and confirm many of these principles will be discussed. Two of these studies, those by Stecher and Solorzamo (1987) and Stecher (1984) were sponsored by the Educational Testing Service. The third study, reported by Morehouse, Hoaglund, and Schmidt (1987) focused on the Minnesota Technology Demonstration Site program.

Three Research Studies on Technology and Teacher Training

The Stecher and Solorzamo study

This study, sponsored by the Educational Testing Service and reported in April 1987, examined the following questions:

1. Are there any models of effective in-service computer education programs?
2. What are the components of these programs, including access to microcomputers?
3. Who are the staff of these programs and what training have they had?
4. Which elements contribute to program effectiveness from the perspective of the staff and the participants?
5. What guidelines for effective computer in-service can be derived from these model projects? (Stecher & Solorzamo, p. 6)

Ten school districts were studied, varying in size and geographic characteristics. The primary data collection tools in the study were experimenter observations and individual interviews. Separate interview protocols were created for the following groups: staff development administrators, computer administrators, school coordinators, trainers, participating teachers and graduated teachers. Each site visit lasted three full days. Extensive field notes and audiotape recordings as well as documentation of various types from the sites were used as data.

The results of this study were presented to correspond to five factors comprising an initial conceptual model presented by the researchers: outcomes, inservice delivery system, teacher characteristics, organizational context and unanticipated factors. A brief summary of major findings under each of these factors follows.

Outcomes. Based on the site visits the researchers related the quality of each district's inservice program on a scale from 1 to 10. One received a 9, seven received a 7 or 8 and two received 6's. In general the researchers were impressed with the quality of the programs they observed.

The judgments of teachers, trainers, and administrators corroborated the researchers' ratings. Most teachers made favorable comments about the inservice activities in which they had participated. Many of these teachers felt their anxiety about computers had lessened and that they could use computers with students. In general teachers were positive about the skills of the trainers.

Negative comments by teachers focused more on external conditions, such as lack of access to computers, than on the inservice experience itself.

The judgments of trainers and administrators indicated they felt computer inservice was well-received. They cited evidence that demand by teachers for such inservice had grown and that district funding had increased. These individuals reported that many graduates of inservice sessions were using computers with their students.

Delivery systems. Twelve specific instructional practices that contributed to successful inservice training in these districts were identified:

1. **Extensive practice with computers.** In most sessions observed at least half the time was spent with teachers working on the computer.

2. **Comfortable and relaxed atmosphere.** A friendly warm atmosphere, often including snacks and opportunities for social interaction, was mentioned by many teachers as important.

3. **Appropriate balance between lecture and guided practice.** A cycle of minipresentations, demonstrations and practice sessions appear to be the most effective approach.

4. **Individualized attention.** Teachers like trainers who answer their individual questions.

5. **Knowledgeable trainers.** Trainers who are knowledgeable about computers and education and who can communicate technical content to teachers are optimal.

6. **Detailed curriculum guides and lesson plans.** Well-planned materials were a visible component of the best inservice programs.

7. **Clear and relevant objectives.** Teachers needed to feel they had a clear understanding of what they would learn and of their responsibilities.

8. **Lesson-related materials and handouts.** Such materials appeared to free teachers from extensive notetaking or reliance on computer manuals.

9. **Inservice lessons linked to instruction.** Teachers liked specific help on preparing materials and experiences for their own students. Teachers appreciated and learned from good modeling on the part of the trainers.

10. **Peer interaction.** Communication among participants during hands-on sessions was particularly effective.

11. **Voluntary participation.** Choosing, rather than being forced to attend inservice training, led to better ratings by teachers.

12. **Strategies for teaching heterogeneous classes.** Trainers who had ways to deal with students of differing levels of prior knowledge and anxiety were more effective. For example some trainers used teaching assistants effectively in helping less or more advanced students.

Where followup occurred, the effects of inservice training were much stronger. A typical example of follow up would be a short session in which teachers could report on their use of an application in the classroom. Although many of the districts in the study did not have exemplary followup procedures, a variety of approaches to followup were observed.

Teacher characteristics. The major finding discussed was the three types of teachers who have received, or will receive, inservice training. The first group consists of highly motivated, eager teachers anxious to build their skill and knowledge base. The second group are those teachers who are less eager but feel they don't want to be "left behind" their peers and their students. The third group consists of those teachers likely to resist training until it is mandated by the district or the State.

Organizational context. These findings related to the problems associated with running inservice sessions separate from the content of the training or the attendees. Often these were problems that an individual school or an entire district had to face as they planned and executed technology training.

1. Logistics. Most respondents in the study felt that the logistical problems associated with running technology training are much greater than with more traditional inservice topics. The acquisition and maintenance of hardware was a major logistical concern. Not only was there a need to insure that the right amount of equipment be available but the proper configuration of equipment needed by the trainer to demo software or engage students in practice.

2. Facilities. Properly equipped facilities were required and these were not always in the most convenient locations. Arrangements had to be made for the use of these facilities. Some districts in the study chose to set up a district-wide training facility where all teachers to be trained would go. While a costly solution, this allowed for more efficiency within the training program because one staff could keep the center well maintained.

3. Time. Courses were often scheduled in the evening or a few days before school began in the fall. Most districts did not have the money to pay teachers to have them participate in summer inservice training activities. When this did occur, teachers reported very favorable reactions. They liked the opportunity to spend extended periods of time learning computer skills without the exhaustion associated with teaching students at the same time.

4. Organization of staff. Many districts attempted to centralize and such centralization increased as districts offered a wider variety of inservice training opportunities. Districts with minimal levels and types of opportunities had little centralization. New career opportunities for teachers often resulted from centralization activity. Teachers who became very involved in computing often became computer coordinators for a building or a district. Some teachers left teaching to take positions in the private sector once they had become competent with technology.

5. Use of outside agencies. The use of college courses or workshops was a common model. Regional or state agencies were also a source of training. In Minnesota, for example, the Minnesota Educational Computing Corporation was a frequent supplier of inservice training for computing.

6. Administrative support. Respondents used the term "commitment" to encompass a variety of indicators, such as the willingness of a building principal to release teachers to receive training, the degree to which the labs were well equipped and well maintained, the extent to which dollars were spent on software acquisition, and the like.

Unanticipated factors. The last category in the model had to do with issues not adequately covered by the other categories and not planned for in the original desired outcomes.

1. Complexity of the learning task. Four distinct types of knowledge were required: how to operate equipment, new classroom management strategies, how to use new software, and how to apply these new software tools to the curriculum. Because learning these new

elements is a complex process, most districts were coming to realize that inservice training in technology requires extended periods of time and a long term commitment of resources.

2. Lack of access to computers. This hinders the process of transfer of knowledge from the training setting to the classroom. Teachers reported frustration with learning new skills and then not being able to access a machine to practice them. Some teachers reported waiting periods of a week or more before they could schedule their students into the computer lab.

3. Lack of lesson-related demonstration. Teachers appear to want a good amount of direct demonstration of how to use a piece of software with students in a specific curriculum area. This application-oriented preference was seen in most of the teachers surveyed.

IBM/ETS secondary school computer education program

Using case study methodology, Stecher (1984) examined the summer workshop component of the Teacher Training Institute (TTI) sponsored by IBM. The TTIs were designed to provide training on the use of computers in all subject matter areas. Schools from eight regions were organized into local networks. Three or more teachers from each secondary school involved were given a one month training program. Follow up training occurred throughout the year at the TTIs.

This study looked at three of the summer workshops involving 28 teachers divided equally between the sciences and the humanities. From three to five teachers from each school represented were included in the sample. The two instructors were from an institution of higher education and had received two weeks of training from IBM.

Primary data collection tools were experimenter observations and field notes, interviews, teachers' diaries, participant written evaluations, informal conversations, and documents generated by participants during the workshop.

The objectives of the 4 week program were the following: to acquaint teachers with the IBM-PC, to help them master the use of various pieces of software, to have teachers develop lesson plans that incorporate computers into the classroom, and to have them plan for the school-wide implementation of computers into their classrooms.

The results of the study suggested that twenty-three factors were significantly related to the success of the TTI #1 training program. A list of these factors is shown in Figure 2 with items in categories listed in order of decreasing importance. Under contextual elements, the availability of hardware was the single most important factor in the success of the program. Teachers needed individual access to machines for as much time as was needed to complete their tasks. The researcher noted that within the four week program, each teacher spent from 75 to 100 hours using the computer. Successful software was applications-oriented and relevant to what teachers hoped to accomplish in their curriculum. It was also relatively easy to use. The classroom faculty itself was comfortable with excellent lighting, chairs, and workspace. Coffee and snacks were made available to teachers; many of them expressed pleasure that so much care had been taken to make sure they were comfortable during the day.

With respect to the program itself, the most important feature was adequate learning time. The practice needed to become familiar with,

and to develop some degree of confidence about operating the equipment and using the software is enormous. From their diaries, the researcher was able to discern how critical exploration time was and how important opportunities for trial and error were in the learning process. Setting realistic and clear goals for the length of the workshop made the teachers perceive they could make substantial progress without becoming overloaded.

The creation of subject-based special interest groups as well as opportunities for teachers from the same school to work together on projects necessitated a good amount of interaction and was a frequently cited strength of the program.

The assignment of specific tasks using various software packages provided the necessary application exercises and also lent structure to free time. Giving teachers too little structure with content that is new and perhaps threatening may lead to wasting valuable time and cause them to become frustrated.

The last category of factors, personal characteristics (see Figure 2), referred to the behaviors and attitudes of the trainers. This study identified several characteristics of trainers that seemed to promote high performance from teachers. One of these was the demonstration of respect for the teacher participants. Many teachers commented upon this characteristic in a positive way, suggesting that not all inservice experiences have been viewed in this way.

Knowledge of both the technical aspects of computing and of education was seen as a critical combination for trainers. A trainer of teachers must not only show high levels of technical proficiency in

operating equipment and using software but must have ideas about how these tools can be used effectively with students. Along with this,

Figure 2

Key Features for Computer Education Programs

Contextual Elements

- Hardware Availability
- Software Selection
- Institutional Support
- Classroom Facilities
- Computer System Features

Programmatic Features

- Adequate Learning Time
- Clarity of Goals
- Group Interaction
- Planning for Implementation
- Structured Lessons
- Software-Based Assignments
- Voluntary Participation
- Attention to Social Needs
- Reduced Distractions
- Use of Supplemental Expertise

Personal Characteristics

- Respect for Students
- Knowledge of Computers and Their Use in Education
- Flexibility
- Familiarity with Schools
- Creativity
- Sense of Humor
- Strength of Personality
- Evaluativeness

Source: Stecher, 1984, p. 41

sensitivity to how schools operate was seen as giving the computer trainers credibility. They need to understand the limitations of schools with respect to technology as well as the potentials. Being flexible, having a sense of humor, showing creative deviations from the course agenda, being able to effectively work with teams of people as

well as individuals were all characteristics seen as crucial to the effective computer trainer. Also, having genuine curiosity about how well the program is working and showing interest in formative evaluation were characteristics mentioned as important.

Minnesota Technology Demonstration Site evaluations

The Minnesota Technology Demonstration Site Program was funded as part of a major technology in education initiative by the Minnesota State Legislature in 1983. One major goal of this program was to inservice teachers within the sites themselves as well as staff from other schools. The evaluation study lasted for a three year period of time (1985 - 1987) and was designed to provide a wide range of information to school districts, the State Department of Education, and other policy and decision-making bodies about how to finance, organize, and implement technology within schools.

Seventeen technology demonstration sites were involved in the study. At each site general information about users was collected. Most sites also looked at student achievement and attitudes through the use of testing and surveys. In some cases data from parents and other groups within the community were also collected.

Inservice activities varied widely across the sites. The most common format was a workshop or class. Other forms included a mobile van containing a large variety of equipment and materials moved from school to school was available to teachers during free periods or after school. Individualized inservice was also provided by demonstration site staff.

Data on teacher inservice took many forms but the most common types of data were narrative descriptions of the types of inservice activity, attendance at the activities, teacher attitudes toward the inservice, building principals' and other administrators' perceptions of the value of the inservice, and some observational data to examine the degree of transfer from inservice to actual classroom settings. A summary of the entire collection of information relating to inservice components of the program across all sites was compiled in a report by the program evaluators.

The results of the study led the evaluators to suggest that there was a progression of inservice technology topics at most sites. At the "awareness" stage: large group workshops run to acquaint teachers with a general overview of how technologies work and to alleviate anxiety. "Overview" workshops that delivered additional detail on how particular technologies work and usually provided examples of the application of technology to particular subject matter areas. "Topical" stage: a more focused approach (e.g., using computers in the social studies) with fewer participants. "Adoption/implementation" stage: more focussed with intense work by each participant. "Integration" stage: characterized by fine tuning of curriculum materials that use technology or guided assistance in integrating certain types of technology into a teacher's lesson.

As a rule, teachers in the study reported that they preferred learning about technology from other teachers or those who understand the settings in which they work (including the limitations/constraints of those settings), that they want access to follow up support, and

that they want access to equipment and software during and after the inservice.

Seventy-eight percent of the sample reported that they participated in the inservice because they were curious, had specifically requested the topic or preferred a technology-related topic to other nontechnology inservices that were available. Nearly 80% of the teachers in the study said that they have either adopted or adapted the application in which they were trained during the inservice.

Interviews with technology site directors or district superintendents indicated that they believed strongly that teachers themselves be involved in the planning of technology inservice activity and that such activity must be based on teachers' needs. They felt that enthusiasm for the use of technology is fostered more readily in a "bottom up" fashion with teachers igniting the interests and curiosities of their peers. Developing reward structures that make it attractive for teachers with expertise to work with their colleagues was perceived as an important step if teachers are to be involved.

The evaluators concluded that for inservice education to be a powerful force in moving technology into classrooms, the inservice activities must have a strong practice or "hands on" component, must be taught by credible sources (most notably other teachers), must meet teachers where they are at in terms of competence, must include follow up support and guidance, must be sufficiently long, and should include extensive instruction in the use of tools.

Areas of Needed Research

While this review has yielded some general principles that seem to predict success in inservice training in general, and technology training in particular, a variety of indicators suggest that there are issues which need more attention from researchers and staff development specialists. Such research should be carried out by universities, school districts, departments of education, hardware and software companies, and others that have a stake in the quality of the teaching force. Specific questions that need addressing include:

* What are optimal sequences of content for technology training? Which skills are best taught early on? Later on?
* What characteristics of teachers best predict their ability to learn about technology? Using technology with students? Staying with it over time?
* What are the effects of different incentives on motivating teachers to learn about technology? To use technology with students?
* Do skills acquired in inservice transfer to the classroom? What elements of inservice facilitate transfer?
* How can the effects of inservice training be assessed in a cost-effective manner?
* Can the cost of training be reduced (such as through the use of peers helping peers) without lowering quality?
* Will requiring experienced teachers to meet technology requirements enhance their use of technology use in the classroom?

* How can partnerships (e.g., school districts - computer companies) be structured to insure that technology training can benefit all parties?

Recommendations

As this report has shown, teachers as a group are under national, state, and local scrutiny. They are being asked to better analyze the needs of their students, to be more efficient managers, to be more knowledgeable in subject matter, and, in general, to become stronger professionals. Along with these pressures, teachers are also being told that they must become competent with technology use in their classrooms. Technology mania has engulfed the nation, including the nation's schools. But while teachers are being exhorted to acquire more knowledge and skills, preservice training programs may actually become shorter in duration at many institutions. Building in time for the development of technology competence within preservice programs is a problem that most college and school of education are attempting to grapple with varying degrees of success.

The problem does not become appreciably easier to solve for the inservice teacher population. Technology training requires expensive equipment in quantities large enough to support plenty of hands-on activity. In order for the training "to take" once it is completed, teachers must be able to access the hardware and software conveniently.

The only conclusion to be reached, however, despite these obvious constraints, is that all of the institutions and organizations involved in teacher training must take the technology problem seriously. It is inconceivable that the effective teacher of the 1990s could be

illiterate about the role of technology in facilitating, managing and delivering instruction or incompetent at integrating its use into many aspects of day-to-day life in the classroom. It is simply unacceptable to settle for only a small percentage of the teaching force being competent with technology. What follows are some recommendations that seem reasonable in light of the many perspectives, issues, and research findings discussed in the previous sections.

Recommendation 1: Training should occur not as a one shot event but as a systematic set of experiences lasting over a period of time.

School districts have invested heavily in the acquisition of both hardware and software. Indicators suggest that they will continue to do so over at least the next several years. In addition to these purchases, schools will be hiring more new teachers to fill the vacancies left by retirements. If technology training is to continue, school districts must maintain an on-going inservice program. This will be a major challenge because of the pressures brought to bear on training and development budgets in school districts. Technology training cannot occur in a short period and, if teachers are to move beyond the simple use of technology to a more integrated instructional approach, significantly different inservice programs accompanied by follow-up support will be needed. As schools districts are confronted with budgetary problems to maintain an active technology training program will be major challenge.

Recommendation 2: Teachers should be encouraged to teach their colleagues about technology but will need special training to do so effectively.

Teachers often express a preference for receiving training from their colleagues rather than outsiders but this strategy will be

effective only if the trainers are competent at instructing adults. It cannot be assumed that such competence is a correlate of competence with technology.

In what ways might teachers "gear up" to provide high quality training experiences for their colleagues? College or university courses focusing on the needs of the adult learner are one source. Districts might provide training for a group of teachers who are good candidates for working with their colleagues. Incentives for involvement might include additional pay, release time or summer employment.

Recommendation 3: Technology training should emphasize the application of technology-based tools.

The 1986 TALMIS report which examines the K-12 market for personal computers and software by surveying the attitudes and predictions of district level computer coordinators toward computer use and software suggests several interesting implications for inservice training needs. Tool use is expected to be the primary educational use of personal computers within three years. As newer and more sophisticated tool packages become available there will be a need to investigate the most effective strategies for teaching teachers to use these packages to improve their own efficiency. They will also need help determining how best to facilitate student use of these tools.

TALMIS data also showed that another trend expected to grow in the schools is more time spent on problem-solving software or that purported to teach "higher level thinking skills". This was the second highest rated computer use category. Many questions remain to be answered about the use of such software. What is the nature of

training needed by teachers if they are to incorporate these programs into their curriculum? Perhaps the onus of preparing and delivering training on tool packages or problem solving software should fall on the producers and vendors of these materials. A good example of this approach would be the training materials developed by MECC. For years they have provided inservice training packages that districts could use to help teachers use MECC products.

Recommendation 4: Incentives are needed to encourage teachers to learn about and use technology.

Currently more than 50% of American school teachers hold masters degrees. (NEA, 1985-86). The incentive for teachers to pursue additional inservice experiences or complete academic coursework related to technology must not be tied solely to the earning of an advanced degree. Both school districts and state departments together must envision incentives for teachers that encourage them to stretch beyond their current levels of expertise, supporting the more novice users and challenging those with greater skills.

Examples of incentives include:

* summer employment
* release time during the school day
* additional pay
* use of equipment at home
* opportunity for travel to professional conferences
* a budget for software acquisition
* tuition reimbursement

Recommendation 5: A clearing house for information on technology training for teachers needs to be established or this function assumed by an existing clearinghouse.

It is apparent that a multitude of activities are occurring across the country related to technology training. Each school of education, school district, and state department of education has a plan of action and is involved in a variety of activities. To obtain a picture of what is happening means contacting hundreds of individuals and agencies. As a result, redundancy occurs, common mistakes are repeated, and few learn from the work of others. A central clearinghouse would be a useful way to collect and distribute information about research on technology training, models of training, and successful approaches to or methods of training. While a variety of computer networks exists, none focus on training efforts.

Recommendation 6: Models of technology training that provide differentiated experiences and context for teachers with different levels of expertise must be implemented.

The Appendix provides a description of one model that the authors of this report have implemented.

Conclusion

The problems facing schooling and the preparation of teachers in this country have been well documented by numerous national reports. Suggestions for reform, and responses to these suggestions, have dominated discussions about education for the past few years and have initiated change in our institutions. Schools of education, for example, are experimenting with significantly different ways to prepare new teachers. Fifth year programs are appearing across the country. The schools are making changes as well. The scope of actual and proposed reform is far-reaching. It is within this context that the issue of technology use and technology training must be considered.

Some would argue that the teacher of the future must be a "teacher technologist", an individual able to use a modem, a hard disc or an electronic gradebook as easily as a textbook or a chalkboard. But movement from where teachers are now to this future scenario will be costly and will require the cooperation of many. Because American teachers as a group are highly educated with more than 50% now holding master's degrees (NEA, 1985-86), school districts, state departments of education, and colleges of education are faced with the challenge of finding incentives to encourage experienced staff to tackle yet one more skill area, that of technology.

Partnerships amongst a variety of institutions and agencies offer opportunities for effective training. Don Rawitsch of MECC makes the observation that three conditions must exist for training to occur: (1) there must be something to be gained from training, (2) resources and (3) expertise. School districts have something to gain from training, have some resources to devote but lack appropriate expertise. A computer or software company may have the needed expertise plus the capacity to subsidize the more modest resources of the school district. If the company perceives something to be gained (such as a market for their hardware or software, or public good will), a partnership could be spawned. The continuous balancing of these three conditions is needed if the partnership is to last. Once formed partnerships can work but require careful planning and monitoring. The "cultures" of schools and business differ in important ways; each partner must work to be tolerant of such differences.

Departments of education have been initiators of widespread technology training in the schools. Departments of education in states like Alaska, California and Minnesota have often led the way, initiating workshops, institutes, and conferences as well as providing incentives for school districts to become involved. DOEs have also encouraged the establishment of certification requirements, a move which affects curricula in colleges and universities and inservice priorities for districts. Unfortunately economic troubles in some states (e.g., Alaska) have reduced capacity to run some existing programs or to initiate new ones. Massive budget cuts, such as in California (Classroom Computer Learning), have virtually eliminated major training centers. If trends such as these continue the role that DOEs can play in technology training may be indirect, such as through the setting of requirements or the establishment of policy rather than through the actual delivery of, or funding for, technology training.

Reduction in state and federal funding will also have an impact on the amount and quality of research that can be carried out on technology training. It has been noted throughout this report that there is a dearth of data about both preservice and inservice technology training practices and effects. Determining how new and experienced teachers perceive training, what models are most appropriate, how to encourage transfer of training to the classroom are but a few of many issues that need exploration. Systematic programs of research are needed and do not exist. Here too, partnerships can be useful. An example is the recently established MECC/University of Minnesota Center for the Study of Educational Technology. The College

of Education at the University of Minnesota and MECC have created an independent organization whose mission will be to promote research on technology in the schools, including teacher training. Funding from a variety of sources will be sought to sponsor this research. School districts will be involved, College of Education faculty and students, and MECC software developers, researchers, and trainers. Partnerships like this one an potentially reduce the current "knowledge gap" about technology training.

Principles of effective technology training, at the inservice level especially, have been identified and confirmed by research. Teachers like to be taught by other teachers or least by individuals who appreciate the complexities of their jobs and workplaces. They want explicit guidance on using technology to help them with specific teaching problems. They demand "hands-on" opportunities and dislike lectures. To encourage the solidification of new skills, hardware and software must be accessible to them after the inservice as well as some form of guidance.

But while these principles seem solid it has been pointed out that the research base to guide decision-making about technology training is thin. With the level of current and projected spending on such training, more insights into how to do it more efficiently and effectively are badly needed.

Informal Teacher Training Strategies

The term "informal" training is used here to denote that training provided outside of academic institutions. Because informal technology experiences comprise part of a teacher's preparation to use

the computer as a part of instruction, it is important to conclude the discussion of preservice and inservice education with a discussion of these agents of training. As this report has demonstrated technology training is not the sole property of schools of education. While schools of education offer college credit for successfully completing computer courses and workshops, they are not the only source of technology training for teachers. Computer companies, software developers, and professional organizations also provide technology training for teachers. In fact, some of these agencies also provide equipment and technical support to schools of education.

Computer Companies and Preservice/Inservice Technology Training

While there are many computer companies and software developers, Apple's, IBM's, Tandy's, and AT&T's efforts related to computer use in the K-12 schools and/or schools of education may be used as illustrations of companies efforts to work with educational institutions. Computer companies have a direct interest in training for several reasons. First, to sell computers to a large district it is often necessary to provide assistance in the training of teachers to use those computers. Second, teachers who learn to use specific technology will want to continue to use the equipment when newer versions are introduced to the market. Training efforts therefore are part of the cost of selling computers.

Apple Computer, Inc. has about 58 percent of the installed micro base in K-12 schools (Barbour, 1987) and has supported teacher training efforts through a variety of company policies. Their most common method has been through equipment grants and special discounts to

districts and educators. However, they have also sponsored teacher training workshops, educational publications, and conferences for educators. The conferences bring together educators to discuss issues related to teacher training. These efforts are chronicled in an Apple publication, Learning Tomorrow.

The inaugural issue of Learning Tomorrow focused on issues highlighted by the Apple Education Advisory Council's meeting. Key questions were:

> What are their (policymakers in schools of education) roles as instructional leaders in an information age?
>
> What are the implications of technology for the curriculum in teacher education colleges and schools of education?
>
> What should the training of teachers involve? Should schools of education prepare teachers with a vision of the classroom of tomorrow, or prepare them for where schools are today?
>
> How can teachers with skills in curriculum and instructional technology become a resource to schools of education?
>
> How can a tenured faculty be retrained to deal with new tools?

Another issue (Linn, 1986) focused on the results of a national meeting with deans and directors of education. The conclusions of the meeting were that the use of technology must be widespread in teacher education courses and preservice teachers should be involved in the evaluation of technological innovations to help students assess the benefits of technology (Linn, 1986, p. 44). Three of the four recommendations are relevant to the discussion.

* Establish partnerships among universities, industry, and schools to respond to the challenge of technology in education.

* Create centers for collaboration on technology and education.

* Create model classrooms and schools where multidisciplinary teams can explore teaching, learning, and technology in real educational settings.

Apple has followed-up on these recommendations by establishing partnerships with colleges and universities. These arrangements include providing "deep discount" programs to creating Apple University Consortium links with 32 leading institutions in information sharing partnerships (Barbour, 1986). Although these programs are designated for the entire college or university, schools of education have benefitted from such arrangements by being able to purchase equipment at a lower rate. This is especially beneficial to schools of education since Apple software is the dominant software used in K-12 schools.

To meet the needs of districts who want training as part of a commitment from a vendor, Apple has also contracted with private corporations and consultants to provide workshops for teachers. For example, Apple has contracted with the Minnesota Education Computing Corporation (MECC) to provide workshops of varying lengths to school districts. Apple pays for part of the instruction and MECC designs and delivers the workshop. In almost all cases these workshops are part of the district's inservice activities in which the district provides the released time for the teachers and Apple provides the trainers.

Apple has also been considering establishing links with selected schools of education across the country for research and development

efforts. At this time, however, the concept is still in the development stage. The major purpose of the centers would be to conduct research and training related to technology issues.

IBM has made a concerted effort in the past few months to increase its presence in the K-12 market. IBM has introduced a new computer, the Model 25, aimed at the school market. While IBM's commitment to the K-12 school market has been questioned by some educators, IBM has sponsored a very large curriculum project, Writing to Read, aimed at the elementary schools and has supported the training of inservice teachers to use the materials and the equipment. In addition, IBM has established working relationships with several software publishers to create materials for the new machines.

According to Mr. Ingo Hentschel, director of inservice education, at the inservice level most of the company's efforts are directed to providing implementation workshops for schools districts who have purchased IBM software. For example, IBM has run state department of education supported workshops in various states on the Writing to Read program. Other efforts include providing equipment for demonstration centers. At the corporate level IBM has not established a company policy about preservice and inservice teacher education.

IBM, like Apple, has also participated in college and university discount programs by making computers and related technology available at reduced prices. In addition, IBM has worked with some schools of education in establishing research programs in teacher education utilizing technology. For example, Dean James Cooper at the University of Virginia has an IBM grant to study the use of computer linkages with

student teaching centers. Such research-based efforts can contribute to a variety of areas related to training teachers to use technology.

The Tandy Corporation has maintained about 18 percent of the computer market in schools (Reinhold, Fran, "Is a powerhouse still a powerhouse with MS-DOS?" September 6, 1987). Within the past several months, Tandy has made a strong bid to increase the its share of the market with the introduction of two new computers, Tandy 100 HX and TX. The computers with MS-DOS have many new features and compete directly with IBM's new machines. Tandy, according to computer analysts, has re-entered the competition with a vigorous strategy (Holly Brady, September 1987)

The Tandy company has throughout its history provided access to informal training through its Radio Shack outlets. Company run seminars and workshops have been offered for individuals interested in learning more about the machines. Such workshops provide opportunities for teachers in school systems using Tandy computers an opportunity to increase their skills.

American Telephone and Telegraph (AT&T) is a recent entry onto the education scene. An example is the relationship with Indiana University. AT&T and the Indiana University School of Education have entered into a cooperative agreement in which AT&T is providing equipment and technical support for the reconfiguration of the school's technology program. AT&T will provide funds for the retraining of faculty and the development of educational programs for both undergraduates and graduates in education. Dr. Lee Ehman, School of Education director for the project, states that the project will permit

Indiana to have the latest technology from AT&T and the funding needed to utilize the equipment effectively in redesigning the curriculum.

The above examples illustrate computer companies' efforts to provide the needed support for the utilization of their technology. It seems clear that vendors can and do provide important opportunities for educators to receive additional technology training.

Software Developers Training Efforts

Education software developers also have an interest in the training of teachers to properly use computers and related software. Each company develops teacher manuals designed to help the classroom teacher use the computer materials more effectively. In some cases these manuals are spartan efforts contained on a single 8x11 sheet while in others the materials are presented in a booklet of several pages in length. Of the current software companies the Minnesota Education Computing Corporation (MECC) has the longest history of active involvement in teacher training.

MECC has been involved in delivering inservice technology training to teachers for 14 years. Originally funded by the state of Minnesota, one of MECC's charges was to train teachers across the state to use technology in the classroom. The state was divided into districts and MECC coordinators were assigned to serve the needs of district schools. Recently MECC's status with the state as changed and it no longer receives direct state funding. According to Don Rawitsch, Vice President for Adminstration, MECC has for the last several years contracted with Apple Computer, Inc. to deliver training nationwide. Rawitsch states that the partnerships has worked because all parties

benefit from the relationship. Schools have the need and will experience benefits from training but have few resources and may have limited expertise in-house. Apple has the resources but does not have in-house highly qualified trainers who can deliver the training. MECC has this expertise but dose not have the resources available to mount a nationwide training program.

A major problem in the MECC/Apple/school training program, according to Rawitsch, is its high cost. MECC estimates that a day of training costs between $200 to $300 per day per teacher. School districts at most are willing to pay $100 - 150 for such services. Because companies like Apple stand to gain from teachers being trained to use their machines, vendors are willing to subsidize some of the cost of the training, thus reducing costs to the school district.

MECC's format for training has not changed appreciably over the years. Workshops with highly qualified trainers and an emphasis on hands-on, active participation by teachers characterizes their methodology. MECC's impressions about the characteristics needed by effective trainers are consistent with the literature but Rawitsch said he also has learned that if very high quality training materials are used, the trainer can take on the role of adviser, consultant and manager.

When asked if he sees that technology-based materials to teach about technology might be a future trend, Rawitsch was doubtful. The cost of producing, updating and maintaining such materials is high. Many school districts do not have the facilities or equipment to operate such programs, content changes too rapidly and teachers often

want more individualistic applications. Rawitsch sees a continuing need for cooperative relationships among schools of education, computer companies, and software developers.

Within the last several years other software developers have made a concerted effort to provide materials to train teachers to use their products more effectively. Efforts by Marge Kosel of Sunburst illustrate these efforts. Working with schools in the field Sunburst has gained a reputation for high quality problem solving activities. Some of their programs such as Factory have received national awards. To encourage teachers to use the products which are more complex than traditional drill and practice programs, Sunburst has developed a series of videotapes to illustrate how a teacher might use the product in the classroom. The tapes show actual classroom applications and provides clues to the teacher on how to organize the students and how to proceed through the lesson. Other material contains a discussion of problem solving in the classroom. These materials provide the interested teacher with a means of learning about the software on his or her own, district personnel with materials for large in-service activities, or material to be used by the sales representative when providing inservice education.

Other developers such as the Agency for Instructional Technology (AIT) of Bloomington, Indiana, provide training materials for their products. AIT has a long history of cooperatively working with state departments of education in the development of technology materials for the classroom. Each set contains a variety of inservice activities to

demonstrate the materials and to train teachers to use them in the classroom.

The above examples are provided to indicate that some computer software developers provide both in-person training and/or materials designed to assist the teacher. It is important for the reader to realize that the examples are illustrations of activities and do not represent a sampling of software company efforts.

Recommendations

Informal technology education will continue to provide important avenues of training for teachers. Because these efforts are often linked to company's marketing strategies and provide insights into the overall success of the company, it is difficult to gain a clear picture of what specific activities are occurring in this area. The following recommendations are designed to provide a better understanding of current efforts.

Recommendation 1: Schools of education, school districts, and informal trainers need to explore cooperative relationships in teacher technology training.

This recommendation has been made earlier in this report. It bears repeating however at this point because it is evident that inservice education and informal education may be the keys to the long term improvement of technology use in tomorrow's classrooms.

Recommendation 2: Informal educators need to study the impact of their training efforts and make these findings available to the larger educational audiences.

Informal educators have the talent to conduct research efforts to explore similar questions raised in the preservice and inservice sections. While the sharing of these findings is always tempered by

the business climate and are sometimes suspect because of their ties to profits, it is important that resources and talent be used to study key questions. Informal educators must be willing to risk studies that may not always lead to the conclusions most conducive to company policy.

Final Comments

The last decade has witnessed an unprecedented commitment to the training of teachers to use a new piece of technology in the classroom. School districts, schools of education, and private companies have allocated considerable resources to meet this challenge. This study examined the status of these training efforts in an attempt to provide guidelines for the next few years. The most clear conclusion from the study is that the task of training teachers to use technology remains as a major problem. The vast majority of America's current teaching staff still need to be trained to use computers effectively as a part of the instructional process. And, of those classroom teachers who have been trained, the level of training is at a minimal level at best. At the preservice level, schools of education have made efforts to provide rudimentary training, but the level of technical knowledge remains low as technology training competes in a crowded teacher education program and for scarce dollars.

As educators look toward the future of technology training several factors provide hope. First, schools of education are in the midst of a reform era that may bring significant changes to the manner in which individuals are prepared to begin their careers. Technology training can be a part of this reform effort that will take several years to fully develop. Second, students entering teaching have had more

experience with technology than in the past and this experience will lessen some of the tension on education programs to "do it all." Also, after several years of lackluster growth, computer companies seem to be on the rebound and are offering educators a wide range of new technology and software to enhance the classroom. And finally, cooperative efforts linking schools of education, school districts, and businesses are being forged. While is only in the infancy stage these early models may be models for others as all three institutions seek to get the most out of limited resources.

The report contains a series of recommendations. These recommendations suggest specific activities that are needed if technology training is to meet the demands of tomorrow's teachers. While many are obvious to an observer of the status quo, they still remain important if educators are to gain a better understanding of the training needs of teachers and the role to be played by key actors -- schools of education, school districts, and private business.

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Appendix

An Inservice Model that Incorporates these Principles

The literature on inservice technology training programs universally advocates that teachers must be met "where they are at" in terms of level of competence and helped to move along the continuum toward greater competence in using technology. Implied in this stance is the need to provide differentiated training for teachers; some will need to start at the ground floor, others must expand on their existing technology related skills. Below, a two level training model is described which includes elements that the authors of this report have implemented in the last twelve years and others that respond to themes that recur in the literature.

Level 1 program

This program is designed to serve teachers who are largely familiar with computer technology.

1. Characteristics of participants. Teachers enrolling in this program usually share a set of characteristics. To begin with, although most are motivated to learn, the source of this motivation varies. Some report that their own son or daughter is "a computer whiz" and that they feel they should know about computers to avoid total intimidation. Others report that they have observed peers using computers with students and are curious about how they might make use of computing in their own classrooms. Still others have general feelings of anxiety about "being left behind" if they fail to learn about these new technologies. Some teachers have found themselves in the awkward position of acquiring a computer, through no effort of their own, and have no idea of what to do with it. Reasons like these

propel teachers to seek out or take advantage of inservice training on computing. It is effective to have participants discuss the reasons for their attendance as a means of exposing both their anxieties and expectations. This sharing of ideas is often cathartic and serves to relieve some of the initial tensions so commonplace in the early stages of training. The question "In what ways have computers made life easier or more difficult for you personally?" usually elicits a flood of tales about bank statements, phony personalized form letters, or problems with bills. This provides a segway into a discussion of the role of computers in conducting ones personal affairs as well as in the teaching/learning process.

Participants in Level 1 training usually anticipate a great deal of hands-on activity at the computer. They tend to be impatient with too much instructor talk; they prefer to spend most of their time on the machine. Many expect to gain specific skills, such as equipment operation and word processing.

In addition, participants enjoy an atmosphere in which they are free to work or chat with others as they experience new tasks. Individuals have different preferences, of course, for working alone or with others, but most welcome the opportunity to seek out support from fellow participants.

The participants in the Level 1 program often have anxieties about computing but are motivated to become competent. An atmosphere of support with opportunities for many "hands on" activities creates an ideal environment for learning.

2. Course content. As time passes, content in the Level 1 program will need to be modified, but some topics are likely to remain stable.

a. Operation of equipment. Everyone learns to turn on the computer, boot a disk, load a program, save, initialize a disk, operate the printer.

b. Knowledge about hardware. This includes information about the internal workings of the computer, using the operating system, the care of disks, various input and output devices, etc.

c. Word processing. Building competence in word processing is a priority early in the program. Word processing provides the teacher with a flexible new tool that can be useful in many aspects of her life. Once she knows how to use it, she can for example, prepare class materials, write letters to friends, and complete assignments for graduate courses. Generally, we believe that teachers should gain a level of comfort and confidence with a single word processing package before they are introduced to other packages which may have different features. Mastering the basic commands and procedures of one package allows beginners to be successful at a variety of tasks.

d. Other tools. The content for a Level 1 program provides an introduction to many applications for teachers. Although there is rarely time for them to become expert users, they have opportunities to practice within each content area. Teachers should try out a variety of programs that will help them create materials for their students. Crossword puzzle generators, packages that produce overhead transparencies or posters, and test generators are some examples of

programs that should be introduced. As with word processing, teachers immediately see the benefits of these programs for classroom applications.

e. Types of instructional programs. Teachers learn about the variety of instructional programs available to them, including drills, tutorials, simulations, games, and problem-solving programs.

f. Software evaluation. Basic criteria to be used in evaluating software are discussed. Teachers are given opportunities to apply these criteria in several reviews.

3. Teaching strategies. By teaching strategies we refer to the ways in which the content of the training is presented, practiced, and reinforced.

a. High structure. Tobias' research (1981) has shown that learners with little prior knowledge about the content of instruction they receive tend to benefit from high levels of structure in the form of instructional support. Our work with teachers in the Level 1 program suggests validation of this principle. We create a highly structured environment which consists of cycles of a preinstructional activity, the instructional task itself, and postinstructional activity. A typical sequence would be to introduce a program, give participants a task in which they must work with the program to perform certain operations, and then debrief on their activity. For example, in teaching about software evaluation criteria, we might first present the concept of good documentation. We might list the characteristics, create a checklist of criteria to look for, and then use the checklist as we review one or two examples of strong and weak documentation. The

assigned task would be to review the documentation from several programs using the criteria included on the checklist. Once teachers complete this task, either independently or in pairs, we would reconvene to debrief about issues like the difficulty of assessing certain criteria or ways to reduce the time it takes to review documentation. This basic cycle, with variations introduced to maintain interest, is repeated at many points in the program.

b. Team work. Teachers both enjoy, and profit from, working together as they learn about computers. Two or three person teams are optimal; more members restrict active involvement by everyone and physically may limit a view of the screen.

Several guidelines are important in establishing and monitoring team activity. First, it is important that each person interact directly with the computer. Some people prefer to stay in the background and let others experiment but it is important that all members of the group have the opportunity to operate the equipment. Second, it is usually helpful to have teams move away from the computer for purposes of planning. Too often when a group remains at the computer, one member wants to play, thus distracting the others and reducing the participation of that individual in the group's activity.

Third, we monitor the groups to catch any serious problems in group dynamics. To illustrate, if one member appears to dominate or to control the computer, it is important to encourage a change in this pattern. Other members of the group may impose internal sanctions but if this does not occur, the instructors should intervene. Related to this problem is the need to carefully structure the task to allow about

the right amount of time to complete it. If too much time is allowed, the group members will become restless and impatient; on the other hand, too little time invariably causes frustration.

The use of groups can be an effective strategy for teaching many skills related to the computer. A careful balance must be struck, however, between time spent having people working together and independently. Some computer skills, such as word processing, require a good deal of practice. Time must be allowed for each person to struggle with learning these skills individually. If each participant does not have access to his own computer during training, it may be important to split the group into two or three subgroups to allow some people to work individually on the available computers while others engage in alternative activities.

c. Supervised individual exploration time. Built into the inservice program at this level is time for exploration and practice. This is crucial for a variety of reasons. It allows teachers to experiment, make mistakes, and try again within a sheltered environment. If something "catastrophic" occurs, such as forgetting to save a file before erasing memory, the teacher can get help from the instructor to understand why this occurred. "Teachable moments" arise again and again as the teacher puzzles over the reasons why the computers mysteriously respond in one way or another. This exploration time also allows individuals to work at their own pace, perhaps returning to earlier assignments and seeking clarification on various operations.

An inservice program for beginners should have at least two broad goals: to create an atmosphere for exploration and experimentation, and to insure that a number of basic competencies are mastered by participants. The combination of methods described above represents a successful strategy for achieving these two goals.

4. Follow-up. This component refers to activities which occur once the formal program is completed.

Inservice programs for teachers typically are structured in one of several ways. They may be intensive sessions of short duration, such as workshops. Alternatively, they may consist of a series of sessions held over a period of time. A university course or an inhouse program may run for 6 to 15 weeks, for example. If the program is offered over a longer period of time, the teacher can begin to experiment with the use of the computer and report her progress at a subsequent session. Because some of our programs have been of the workshop variety, we have found a need to conduct follow up activities. Many options are possible; we will report on several that have worked well for us.

Assigning a project to use the computer within a lesson has been useful. We encourage teachers to do a simple activity at first. For example, they may have their students learn the LOGO primitives learn to use Bank Street Writer, or make posters with Printshop. A teacher might use a drill to reinforce a mathematics rule or a tutorial to help students learn about the basic food groups. By building in a requirement to carry out such an activity, and report on their results, teachers have the incentive to take the first step in using the computer with their own students.

Another follow up strategy is to send a survey to participants, querying whether and in what ways they have used the computer after the inservice program. Not only do we receive information about usage, but it also serves to remind those who haven't used the computer about possibilities for classroom and personal uses.

The ideal inservice program will integrate ongoing formal training experiences with actual application in the classroom. When this is not feasible, follow up activities can be generated which insure that participants will engage in some level of application.

Level 2 program

A second stage of training for teachers who have experience using the computer focuses heavily on tool use and classroom integration.

1. Characteristics of participants. The most compelling difference between participants in the two levels of our program is the degree of familiarity with the computer. The effects of having experience manifests itself in several ways with advanced participants. Unlike the beginners, these participants are comfortable with the technology. Operation of the equipment has become automatic and as a result, they tend to have much less anxiety about its use.

Advanced participants' expectations for additional training center around needs to expand their current use of the computer as a tool for completing professional and personal tasks. Specifically, they wish to broaden their outlook on ways to use this technology for extending their own powers to reach students. These teachers already have experienced both success and failure in working with different software and are more willing to take some risks. The novelty of working with

the computer has lessened and these participants are ready to deal with more sophisticated issues about applications.

Another expectation shared by most advanced participants is that they will profit from hearing about the successes and failures of others in the group. Many expect to learn as much from one another as they will from the instructor. Because many of these participants regularly consult with other teachers as they experiment with computing in their own buildings, they realize how helpful such shared expertise can be.

One motivator for some participants in Level 2 training is the press to inservice their fellow teachers about computing. Working with other teachers will require knowledge and skill which may in part be different from that needed to work with their own students. Participants may hope to gain strategies for delivering good inservice instruction.

Some of the advanced participants have begun or hope in the future to create their own software and look to the advanced program as an opportunity to pick up helpful hints for this activity. Some have concluded that little of the existing software meets their needs; others who have programming skills welcome the challenge of creating new material. Although these participants always represent a minority, their needs can be partially addressed through some aspects of the program.

Level 2 participants often have clearer expectations about what they need from further training. Because these individuals have the basic competencies presented in the introductory program, they wish to

have their current knowledge and skill base enriched in some very specific ways.

2. Course Content. Content in the advanced program is presented in five general areas, including principles of effective instruction, instructional design, classroom management, advanced tool and application use, strategies for inservice training, and software evaluation. The specific content presented may be briefly summarized in the following manner.

a. Effective instruction and instructional design principles: Principles of effective instruction and effective instructional design are presented. Demonstration of these principles within technology-based instruction is provided. Participants practice applying these principles in a series of exercises provided by the instructor and in the design of their own instructional lessons which incorporate computers in one or more ways.

b. Classroom management: This area covers issues of incorporating the use of computers in the classroom. Participants are encouraged to consider how the computer can be used for individual, small or large group instruction. Strategies for designing pre-instructional, instructional and post-instructional activities are demonstrated and practiced.

c. Advanced tool and applications use: Most Level 2 participants are experienced users of some tools and applications so this training allows them, under guidance from the instructor, to experiment with unfamiliar programs and to expand their repertoire of tools.

d. Strategies for inservice training: This area covers strategies for planning and delivering inservice training for teachers on the use of computers. Deciding what to present, how much time to allow for various topics, accommodating the backgrounds and interests of different participants, and giving good demonstrations are some of the topics which are covered.

e. Software evaluation: This area focuses on developing systematic procedures for software evaluation within a school or school district.

The content for this program focuses on effective integration of computers into the classroom and the curriculum. Because teachers who attend such sessions may serve as resource people to their colleagues, strategies for inservice training are demonstrated and practiced.

3. Teaching strategies. We continue to use many of the methods from the Level 1 program but introduce several different ones as well.

a. Peer teaching. An important goal of this advanced program is to give participants opportunities to practice training other teachers. Teachers may work individually or in small teams to plan, deliver, and evaluate one or more inservice training sessions. Usually, the schedule is arranged so that each practice session can be taught twice. In this way, evaluative feedback from the first session can be used to modify the second one. As instructors, we observe and critique these sessions and if possible, involve other participants in this process. This activity gives participants an opportunity to follow an instructional design process in which the recipients of the instruction are adults rather than children.

b. Instructional project. Application of the effective instruction principles presented in the program is achieved by the assignment of a project. The participating teacher must identify an instructional problem, create an instructional sequence that uses technology, pilot it with his or her students and report the results. The computer must be incorporated into one or more aspects of the design. The project can focus on one mode of operation only, such as individual instruction, or can combine aspects of individual, small, and large group activities. Each phase of the project is shared with other participants to encourage generalization of the principles to a variety of instructional tasks.

A necessary ingredient of this project is a teacher's guide. In order to encourage the designer of the instruction to be explicit about his assumptions, he must document the process so another teacher could teach the lesson or unit and be reasonably confident about its outcomes.

c. Readings. The Level 2 program encourages participants to do more reading than the Level 1 program. Chapters and articles about instructional design, effective teacher behavior and computer-based instruction are made available.

The Level 2 training requires that participants be able to bring together new knowledge about instructional design and effective teaching with their competence in computing to create systematic, validated instructional sequences for both their own students and for their fellow teachers. The teaching strategies used in this program

focus on helping teachers move beyond isolated applications of computers to well planned, validated experiences for students.

4. Follow-up. Follow up activities for Level 2 participants often take the form of providing information about additional resources. For example, the teacher may wish to attend a more indepth seminar on aspects of instructional design or may be receptive to additional readings on this topic or that of effective teaching. Some teachers may select the path of creating their own software. They will need help in the use of authoring systems or programming skills. Providing further assistance on inservice training activities can be provided in several ways. Level 2 training participants can be asked to keep a log of problems arising as they conduct such training. Sessions can be held which bring together individuals involved in inservice training to discuss strategies. Teachers who have completed the advanced program like to learn about new software that they can use with students. A simple newsletter announcing, reviewing, and providing suggestions for the use of new products can be a welcome aid to busy teachers who have little time to go through commercial catalogs and read journals.

Summary

In this two level approach to inservice training on computing, we have attempted to create a developmental environment for teachers which is responsive to their current degrees of experience, their expectations, and their levels of comfort with the technology. What might a third level of training entail? One possibility is that participants would begin to develop their own software to meet specific

needs using authoring systems or programming languages. Those who have acquired a knowledge base in instructional design and effective teaching principles would be in a good position to make this transition. Another option would be that participants engage in research on variables related to effective computer-based instruction. Working in conjunction with individuals such as university faculty who have research design skills, teams of people might begin to investigate a variety of variables that could enrich our knowledge base about how best to use these new and exciting technologies in the classroom.

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Dear ^F2^:

The Office of Technology Assessment, under the auspices of the U.S. Congress, has asked us to conduct a review of literature on the topic of teacher technology training at the preservice and inservice levels. To help us in our review we would appreciate receiving from you any documents produced by your organization that relate to this topic. Examples of such documents might include:

- lists of competencies/skills teachers should possess for technology use in general or related to a specific subject matter area
- curriculum guides for technology training for teachers
- sets of recommendations for how teachers should be trained to use technology in their classrooms
- evaluation instruments that assess attitudes toward technology or competence with technology
- reports of staff development efforts aimed at technology training
- other publications about technology training for teachers
- surveys of teacher attitudes/needs related to technology

Because we are working on a short timeline we would like to receive your materials by July 17. Also, we would appreciate receiving the names and telephone numbers of other individuals in your organization who you think could be helpful to us on this project.

We look forward to hearing from you. Thanks.

Sincerely,

Carol A. Carrier
Assistant Dean

Allen D. Glenn
Associate Dean

CAC:ADG/vgl